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TWO HOMEMADE SPRAY BOOMS FOR MAINE APPLE ORCHARDS

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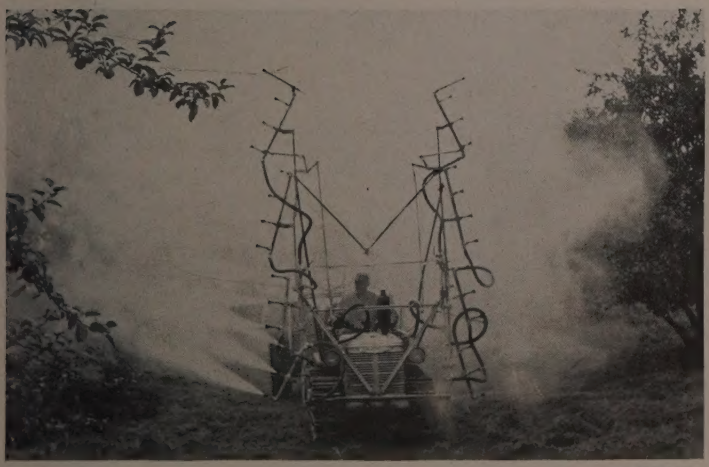

The Highmoor Sectional Spray Boom in Operation

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CONTENTS

	PAGE
Advantages of Spray Booms	355
Disadvantages of Spray Booms	356
Desirable Characteristics of a Spray Boom	357
Construction of the Highmoor Spray Booms	358
The Highmoor Multiple-Nozzle Spray Boom	359
The Highmoor Sectional Spray Boom	363
Some Observations on the 1947 Performance of the Highmoor Spray Booms	367
Conclusion	368

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TWO HOMEMADE SPRAY BOOMS FOR MAINE APPLE ORCHARDS

By
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From the early days of commercial orcharding to the present time, growers continually have been improving their spray practices, with the object of obtaining more effective control of diseases and insects, and at the same time securing increased economy of time, labor, and spray materials. Improved machinery for spraying and dusting has played an important part in the development of modern orcharding, and the development of more efficient methods for orchard spraying has been accelerated during the past 4 or 5 years.

The single nozzle gun and the multiple nozzle broom have been replaced to a large extent in some orchards by mechanically operated spray booms, attached in various positions on the spraying equipment. Among the commercially available spray booms may be mentioned the Bean Spray Mast, the Farquhar Oscillating Spray Head, the Hardie Multi-Nozzle Boom, and the Automatic Spraying Unit of the Grand Traverse Orchard Supply Company. Other kinds also are available. Some other new kinds of equipment for applying spray and dust materials have been developed and tested for orchard use. Among the newer machines being offered for orchard use are speed sprayers, fog applicators, liquid dusters, and machines that apply concentrated mixtures of spray materials. The more radical developments are still in the experimental stages, and have not yet gained acceptance in Maine. The use of spray booms, however, has proved entirely practical in a number of Maine orchards and the discussion here is limited to the description of spray booms mounted in various positions on the conventional type of spray machine in general use in Maine orchards.

Advantages of Spray Booms

There are at least 5 advantages that may be obtained from the use of spray booms:

(1) The "human factor" in spraying is considerably reduced. Instead of relying on the judgment and ability of an individual for proper coverage, the spray nozzles can be so arranged that more thorough and more uniform coverage is obtained automatically.

(2) Orchard plantings can be sprayed more quickly—an important consideration in modern orchards which may be so extensive that the time required for coverage increases the difficulty of disease and insect control.

(3) Some of the physical labor required in spraying is lessened, and the spray crew does not become fatigued so quickly. This is an imporant consideration since a tired man may become careless and inefficient.

(4) Usually an orchard may be thoroughly sprayed by means of an efficient spray boom with less material than is required by hand-operated guns and brooms.

(5) Some booms save labor because they are automatic or are operated by the tractor driver.

DISADVANTAGES OF SPRAY BOOMS

Although the facilities and time available have not permitted extensive observations, it has been noted that at least some of the spray booms in use have certain disadvantages.

(1) The "human factor" in spraying may not be reduced as much as seems possible. Most spray booms which are designed to operate when mounted in various positions on the spray tank, for most efficient operation require rather constant attention to direct the spray onto upright and outward growing branches. Some types require that one man ride on the back of the sprayer and frequently change the angle of the spray boom when taller or shorter trees are encountered. With the few kinds of spray booms that may be operated by the tractor driver, he in addition to driving the tractor, may also have almost a full-time job directing the spray nozzles. The more nearly automatic types require only adjustment for the average tree in the orchard, and then a supplementary hand gun for "touch up" work where the spray has missed a particular part of the tree—which reduces the "human factor" but requires that one man ride the spray tank to watch every tree.

(2) The speed with which some types of equipment need to be driven through orchard plantings in order to operate most efficiently is a limiting factor under Maine conditions. While perhaps well suited for some regions, some of the spray booms on the market are not properly designed for use on the rough terrain that characterizes most of the orchard sites in northern New England.

(3) Although the physical labor is lessened, many of the commercially available spray booms require 2 men on the spray machinery at all times, a tractor driver and a man to ride on the spray tank. It seems more satisfactory to have the spray boom mounted on the front of the tractor, and to have the boom either entirely automatic or operated by the tractor driver with a minimum of effort, eliminating 1 man from the spray crew.

(4) Observations in Maine show that some of the newer spray booms, while using less gallonage than more conventional equipment, still use more spray material than necessary for disease and insect control. Observations on commercial types of spray booms operating in Maine during 1947 revealed that during any particular application one applied about 20 gallons per tree and another applied about 12 gallons per tree, when both spray booms were used on mature, bearing McIntosh trees. Both these amounts are considered excessive, on the basis of research during the past few years, where a definite attempt has been made to control disease and insects with a minimum gallonage of spray per application. A more complete discussion of this point is included in "Recent Advances in Spray Practices in Maine Apple Orchards," Bulletin 457 of the Maine Agricultural Experiment Station.

Desirable Characteristics of a Spray Boom

In 1946 and 1947 an attempt was made at Highmoor Farm to construct a spray boom that would be efficient for use in Maine orchards. A good spray boom should embody certain desirable features, and in constructing the experimental spray booms at Highmoor Farm the object was to incorporate as many as possible of the following characteristics:

(1) The "human factor" should be reduced to a minimum. The nozzles should be so arranged that good coverage is automatically obtained, and yet the spray boom should have sufficient ma-

neuverability to permit the operator to spray the occasional high-topped tree or the outward-growing branch that is difficult to reach.

(2) Since good scab control depends a great deal on timeliness, the equipment should be capable of fairly rapid operation on the kind of terrain that characterizes the usual orchard site in Maine, and yet not sacrifice the ability to cover all parts of the tree with the spray.

(3) There should be a maximum saving of labor. The conventional method of spraying, and most of the commercially available spray booms, require at least 2 men on the spray outfit, a tractor driver and a man on the spray tank. A more desirable arrangement seems to be a fixed boom that requires little hand manipulation, and is mounted on the front of the tractor. Such a boom requires only 1 man, the tractor driver, and is in such a position that the driver can see and direct the spray with the least effort.

(4) A satisfactory spray boom should permit thorough and complete coverage, without waste, and with a minimum of gallonage of spray material.

(5) The spray boom should be almost vertical, with the spray nozzles so arranged in a fixed position that good coverage is obtained automatically. A "sweeping" motion of the nozzles may result in a particular part of the tree being sprayed 2 or 3 times while another part of the tree may be missed entirely.

CONSTRUCTION OF THE HIGHMOOR SPRAY BOOMS

After some preliminary tests, an attempt was made in 1947 to construct a workable spray boom for apple trees in Maine. At the start of the 1947 season, the only spray equipment available at Highmoor Farm was a 400-gallon machine with a 35-gallon-per-minute pump. A little later in the season a new sprayer was obtained; a 600-gallon machine with a 55-gallon-per-minute pump. Spray booms were built for both machines. The easier boom to construct was designed for the 35-gallon-per-minute machine, and this boom will be described first. It is realized that each grower constructing a spray boom will make modifications to meet his special conditions and requirements. The descriptions of the 2 booms discussed here are intended as suggestive, and need not necessarily be followed in detail.

The Highmoor Multiple-Nozzle Spray Boom

Spray booms of various shapes were tested, with the first thought being that a crescent shape would be the most desirable. After some preliminary testing, however, it was found that such a boom did not give as satisfactory coverage as could be obtained if the boom was more nearly straight and vertical. Various shapes of more nearly vertical spray booms were then tested. Some of these were about intermediate between crescent shape and vertical, with the bottom and top of the boom curved away from the tree, while the middle of the boom almost touched the tips of the branches about half way up the tree. Others had only the middle of the boom curved away from the tree while the bottom and top of the boom curved over the tips of the branches at the bottom and top of

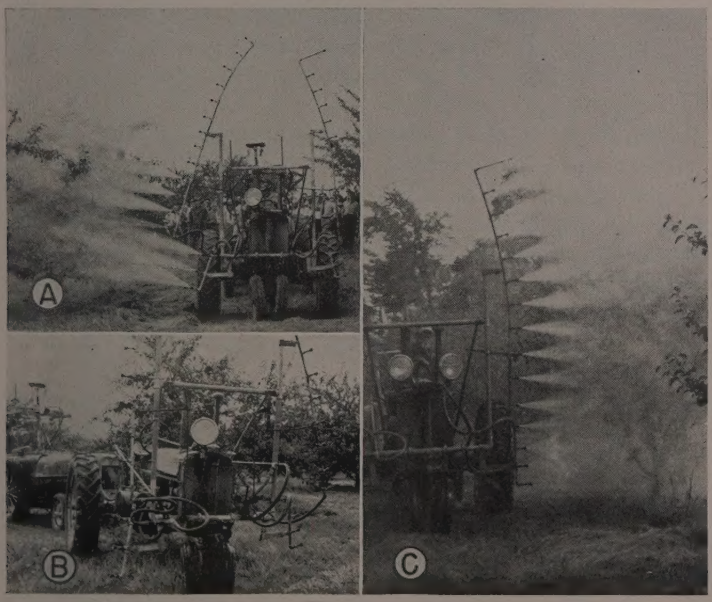

Figure 1. The Highmoor Multiple Nozzle Spray Boom.
A. Spraying apple trees with the boom as finally developed.
B. A view of the support frame on the front of the tractor.
C. Spraying young trees with one boom.

the tree. Finally, it was found that the best deposition of spray material resulted when the boom was almost vertical, curving slightly away from the tree at the top. In Figure 1-A, the spray booms shown are the final developments from this testing process. The boom being used to demonstrate spraying is the one finally adopted. The boom on the opposite side of the tractor represents the last of the more strongly curved booms that were built. As can be seen in the illustration (Fig. 1-A), this boom is curved to a greater degree than the one finally adopted. In the illustration the boom being used to demonstrate spraying has been tipped upward to illustrate its maneuverability.

This boom consists of 2 sctions, the smaller and lower section having 3 nozzles, and the larger, upper section 13 nozzles. Details of the construction are shown in Figure 2. The boom is made of 9-inch lengths of ¾ inch pipe, joined together with "T" joints. A reducer from ¾ inch to ¼ inch is inserted in the open end of each "T," and the spray nozzle is mounted on a 4-inch piece of ¼-inch pipe. The boom may be made longer or shorter by simply adding or removing some of the 9-inch sections of pipe. Tests on 20-year-old bearing McIntosh trees at Highmoor Farm showed that a total of 16 nozzles was about all that could be used satisfactorily with a 35-gallon-per-minute pump. The total number of nozzles would depend somewhat on the size of the discs used, but it was found that small discs, such as No. 3, when used in all the spray nozzles, gave satisfactory coverage. Late in the growing season, when the foliage becomes more dense, No. 4 discs were sometimes used in the upper 2 or 3 nozzles, in order to assure good coverage in the tops of the trees.

The multiple-nozzle spray boom is mounted on a removable frame that is attached to the front of the tractor. The smaller section is canted slightly upwards and bolted into place. This may be manually adjusted for the type of tree in the orchard. If one is spraying upright-growing varieties, such as Northern Spy, Delicious, or Early McIntosh, this small section of the boom should be canted slightly more than when spraying McIntosh or Cortland. Usually it is a simple matter to arrange the angle of this section of the boom to suit the trees in a particular orchard. The longer section of the boom is mounted on the frame by being bolted at a point slightly more than half way up the section. This bolt is not drawn

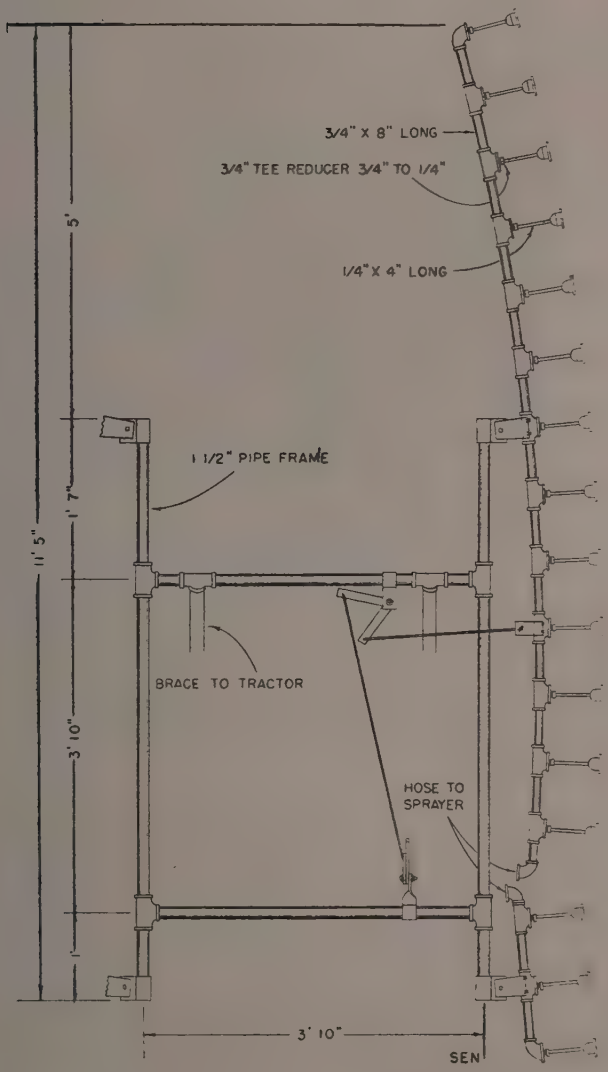

FIGURE 2. Diagram of the details of the Highmoor Multiple Nozzle Spray Boom and the Support Frame.

up tightly, so that the angle of the boom may be changed, in order to spray the occasional high-topped tree or outward-growing branch. This movement of the boom is accomplished by means of a lever beside the tractor driver. From this lever a rod extends along the tractor to the lower part of the frame holding the boom. There the rod is jointed to one end of a movable, V-shaped, piece of metal, pivoted parallel with the rod. To the other end of the V, another rod is attached, and extends up to the top of the frame where it, in turn, is attached to one end of a similar pivoted V-shaped piece of metal. From the other end of this second V-shaped metal piece, a rod extends to the boom, where it is loosely fixed to a flange welded onto the boom section. Some of the details of this are shown in Figure 2. A movement of the lever by the tractor driver will in turn move the boom so that the spray can be directed upward toward high topped trees, or downward, if desired. It is important that some provision be made for this movement of the boom while spraying, yet the less movement that needs to be made, the better. It was found that for the average bearing tree at Highmoor Farm, a boom such as described, required only an occasional adjustment in order to secure thorough coverage of the trees with the spray material.

Although Figure 1-A shows 2 booms mounted on the front of the tractor it proved impractical to operate both booms at the same time when using a 35-gallon-per-minute pump. Such a pump would deliver sufficient volume of spray to operate both booms when No. 3 discs were used in the spray nozzles, but the spray lacked sufficient drive for thorough coverage. When only 1 boom was used the volume and force of delivery of the spray was entirely sufficient for thorough coverage, even when the weather was windy enough to interfere with other types of spray machinery. It is possible to operate such a single boom with a pump capacity of less than 35 gallons per minute, but more satisfactory performance probably will result if the number of spray nozzles is reduced to perhaps about 12. Growers who attempt the construction of such a spray boom may find it profitable to experiment some to determine the proper number of nozzles for the sprayer being used. Thorough coverage of the foliage depends not only upon the volume and force of delivery of the spray, but also upon the character of the trees. Well pruned, open trees are easier to spray, and require less drive

of the spray material than trees with dense foliage and numerous, overlapping branches. In any type of spraying, the pump capacity should be sufficient to give thorough coverage of the foliage with the type of spray nozzles being used. Pump capacities of 20 gallons per minute can be used with spray booms, but capacities lower than this are not to be recommended. Capacities of more than 20 gallons per minute probably will prove more efficient for spraying with the variable weather conditions that occur in most orchard areas.

The spray material is delivered to the spray booms by means of pipes bolted along each side of the tractor, with a single intake at the rear of the tractor seat. A short rubber hose connects this intake with the delivery pipe from the sprayer. Shut-off valves are inserted in the pipes along the side of the tractor at a point within convenient reach of the tractor driver. These shut-off valves enable the driver to use either boom at will and also to shut off the spray between trees, when desired. The arrangement of these pipes is shown in Figure 3-C. Although this particular illustration shows the tractor used to operate the Highmoor Sectional Spray Boom, the arrangement is exactly the same as that used on the tractor that operated the Highmoor Multiple Nozzle Spray Boom.

The Highmoor Sectional Spray Boom

Early in the 1947 season, a new sprayer of the latest design with a 55-gallon-per-minute pump, became available for experimental work. Since an almost vertical spray boom had proved most efficient in previous tests, it was decided to attempt the construction of a vertical boom that would have greater maneuverability than the ones previously tested. A boom was built in 4 sections, each of which could be adjusted separately. This boom was mounted on one side in front of the tractor. A similar boom was constructed and was mounted on the other side of the tractor in order to learn if one side of each of two rows could be sprayed efficiently at the same time.

Details of construction are given in Figure 4, and the frame support for this boom is shown in Figure 5. The kind of support frame built by anyone interested in constructing a spray boom will necessarily depend on the kind of tractor used to haul the sprayer. The frame support illustrated here was built to suit the International tractor used at Highmoor Farm, but the principles of con-

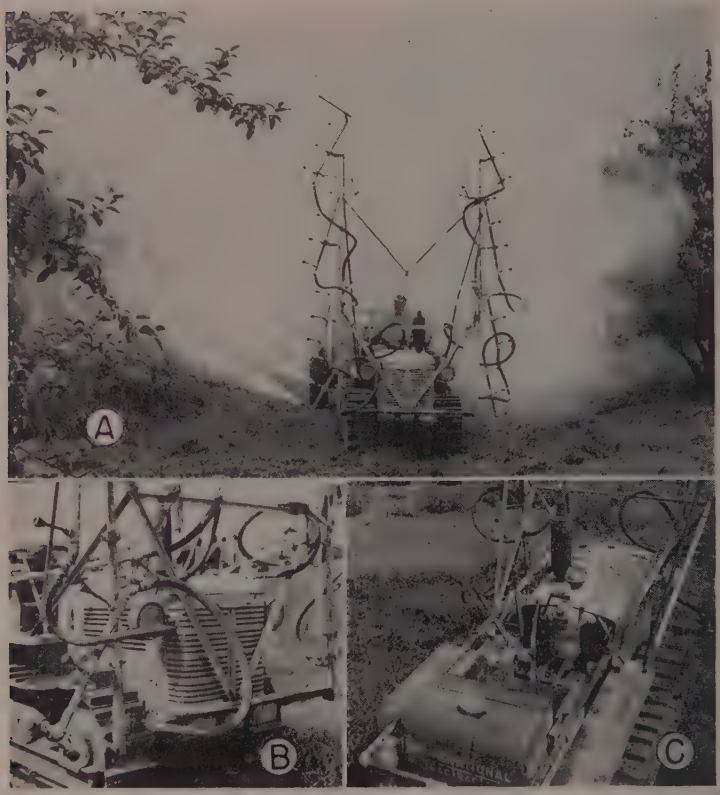

FIGURE 3. The Highmoor Sectional Spray Boom.
A. Spraying one side of two rows at the same time. B. The lower part of the support frame on the front of the tractor. C. A view of the tractor showing the arrangement of pipes and shut-off valves.

struction will apply to any tractor. A strong support frame is needed to give rigidity to the spray boom, and to prevent whipping and subsequent breakage when driving over rough ground.

The spray material is piped from the sprayer to the booms by means of a pipe frame that fits around the sides of the tractor. A single intake from the sprayer is located just behind the driver. Shut-off valves are inserted in the pipes on each side of the tractor within convenient reach of the tractor driver so that either or both booms can be used at will.

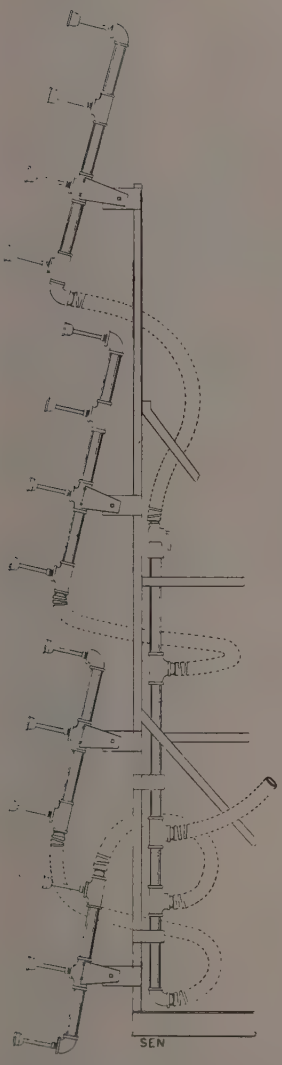

FIGURE 4. Diagram of the Details of the Highmoor Sectional Spray Boom.

As shown in Figure 4, this boom consists of 4 sections, the upper 2 having 4 nozzles each, and the lower 2 having 3 nozzles each. Each section is made of 1-inch pipe cut into 9-inch lengths, and joined together with "T" joints. A reducer from 1 inch to ¼ inch is inserted in the open end of the "T," and the spray nozzles are mounted on lengths of ¼ inch pipe. Each section of the boom is bolted to a flange welded onto an upright support, and is adjustable at the point of attachment. The top section of the boom has an arrangement (previously described) which enables the tractor driver to move this section by means of a lever.

The spray enters the boom by means of a length of 1-inch pipe parallel to the upright support. This upright pipe is fitted with 4 outlets, each connected by means of spray hose to a section of the boom. A shut-off valve, inserted in the spray pipe leading to the top section of the boom, permits the top section to be turned off when spraying small trees.

Although 1 inch pipe was used in constructing this boom it is thought that ¾ inch would be preferable. There is less weight and consequently less danger of breakage, and also because of the smaller diameter of the pipe a shorter period of time is required to attain adequate pressure after the pump is started.

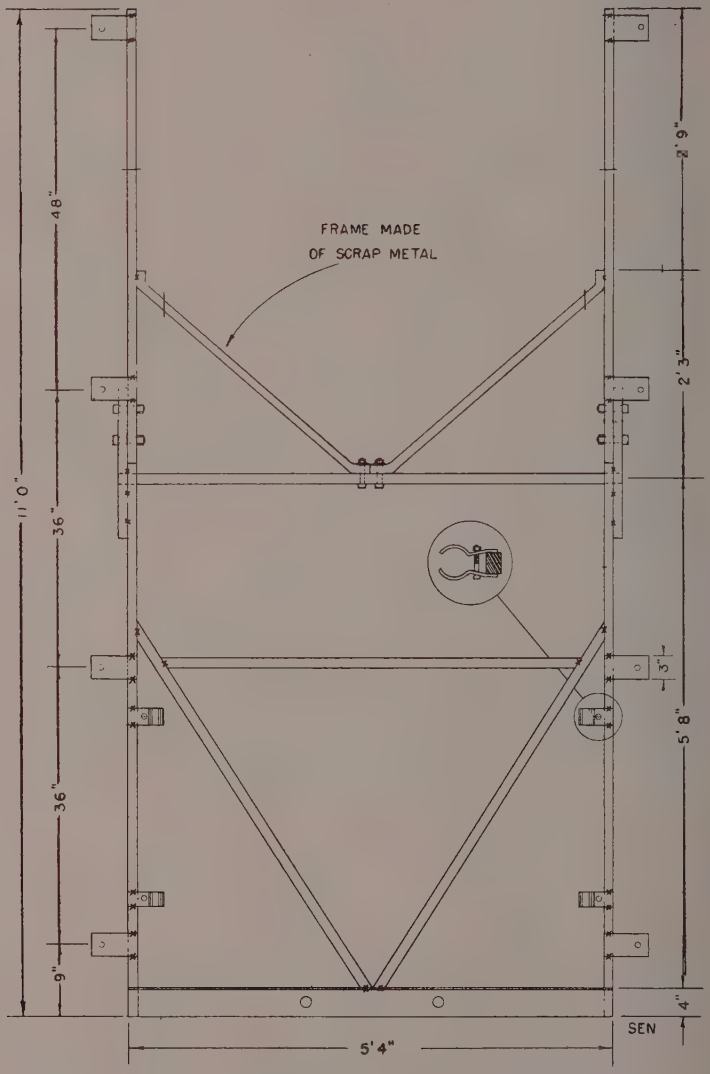

FIGURE 5. The Support Frame for the Highmoor Sectional Spray Boom.

Some Observations on the 1947 Performance of the Highmoor Spray Booms

Construction of the two kinds of spray booms in satisfactory form was completed at Highmoor Farm at about the time of the petal-fall spray, and the booms were used almost exclusively in all the cover sprays applied in the various orchards. Rather detailed records were obtained on their performance in 1 block of about 500 McIntosh trees 24 years old. Previous records showed that when using an 8-nozzle broom and spraying from a tower on top of the sprayer an average of 6½ hours was required to spray the block and an average of 3800 gallons of spray material was used. This 6½ hours was the total time required for all operations, driving the spray machine from the storage shed to the orchard, hauling water, mixing spray materials, spraying, and returning to the storage shed. Records taken during the 1947 season showed that, with the use of the Highmoor Sectional Spray Boom, the same orchard could be sprayed in about 3½ hours and with an average of close to 2600 gallons of spray. In some sections of the orchard both booms would be turned on and the near sides of the 2 adjacent rows sprayed at the same time. In other areas because of rough terrain or smaller trees in 1 row only 1 side of the boom would be used. It is clear that by using the boom, instead of an 8-nozzle spray broom, there was a saving of about 45 per cent in the time required to spray, and a saving of about 30 per cent in the gallonage of spray material used. Because only one man was required to operate the boom, in place of the two used in spraying with hand guns, there was a saving of approximately 73 per cent in man-hours of labor required for applying the spray.

A comparison of the orchard operation of the two Highmoor booms described here showed advantages and disadvantages of each. If a particularly large tree was encountered when using the Multiple Nozzle Boom and the upper section had to be tipped enough to apply spray to the top of the tree, the distance between the bottom spray nozzle on the longer section and the upper spray nozzle on the shorter section would be such that coverage of the foliage opposite this part of the boom was rather poor. This disadvantage was overcome when the Sectional Boom was used since only the top section needed to be moved in order to cover properly

the tops of tall trees with spray material. This top section did not have to be moved enough to interfere with thorough coverage in the part of the tree opposite this part of the boom. One obvious disadvantage of the Sectional Boom is the 4 separate spray hoses. These may cause trouble by breakage but little difficulty with this should be experienced, if the equipment is serviced regularly and worn parts replaced.

Experience in the 1947 season showed that the advantages of these spray booms far exceeded the disadvantages. The "human factor" in spraying was reduced to a minimum. It was possible to have men operate the equipment who have had little experience with apple spraying, and yet obtain satisfactory coverage. The use of inexperienced spray men is not recommended, however, if it can be avoided, even when spray booms are operated.

The time required to spray a given orchard was considerably reduced, even when using 1 man less in the spray crew. It was found that the limiting factor in the speed with which the booms could be operated was the time required to haul water to the equipment. Preliminary observations show that if water could have been more readily available to the sprayer the equipment could have operated more efficiently, and the time required to spray the orchard could have been reduced considerably more than 45 per cent.

The physical labor of spraying was considerably lessened. Although the tractor driver did all the spraying, the booms were so automatic that only an occasional tree required any extra attention. Then only a movement of a lever was required to adjust the spray boom. Care was necessary when trees were encountered with branches growing out into the roadway between the rows, but this difficulty is more properly overcome by judicious pruning, such conditions would have bothered the tractor driver whether he was doing all the spraying or simply driving the equipment through the orchard, and would also have interfered with a man using a hand-operated spray gun.

CONCLUSION

Two types of homemade spray booms here described were developed at Highmoor Farm, where they proved more efficient than hand-operated guns. Experimental tests showed that the use of the

booms saved 45 per cent of the time required for spraying, 30 per cent in gallonage used, and 73 per cent of man-hours of labor of applying the spray.

These booms are so designed that the construction is rather easy and either boom may be made with a minimum of tools and facilities. Growers who may attempt construction of either or both of these spray booms may wish to make changes in the design to meet individual requirements. One change probably will appear obvious to those who give the subject much thought—the angle of the spray nozzles could be changed in such a way that while remaining vertical they would not all be in the same plane. In other words alternate nozzles on the boom could be canted so that one would point slightly ahead of the boom and the other canted slightly behind. Experimentation will be undertaken on this and other points in coming years, in an effort to construct still more efficient spray booms.